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Sound Money League of Pennsylvania

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The Future Price of Silver.

By ELLIS CLARK,
MINING ENGINEER.

Author of "Notes on the Progress of Mining in China," "The Silver Mines of Lake Valley, New Mexico," etc.

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The present and prospective cost of mining an ounce of silver, which the writer has been requested to ascertain by the Sound Money League of Pennsylvania, is a subject the elucidation of which must ever be surrounded with many difficulties, both technical and practical. Dividing the subject into its two natural heads, and studying at first the present value of an ounce of silver, we ascertain in our studies of the subject that this value has been rapidly, greatly and forcibly diminished since the latter days of June, 1893, when the report of the Hershell Committee was made public, ordering the closing of the Indian mints for the private coinage of rupees. Later in the same year came the repeal of the Sherman law for the purchase of 4,500,000 ounces of silver per month, but, contrary to expectation, the fall in the price occasioned by this action was by no means so severe as had been expected. The effect of the closing of the Indian mints to the free coinage of rupees was to cause a drop in the price of silver in the London and New York markets from 82–84 cents to 62 cents per ounce Troy.

Subsequently there was a recovery, the price entering the 70's; but another fall took place between October 24, 1893, when the unconditional repeal of the Sherman law was assured, and October 31, 1893, from 73⅜ cents to 68 cents. From that time to the present writing, September, 1895, the price of silver in the markets has varied between 60 and 70 cents.

It is now selling in the markets of the world for between 66 and 67 cents per ounce:

FLUCTUATIONS IN MARKET PRICES OF SILVER.

This resumé, though apparent to every one who studies the political economy of the day, is necessary for the benefit of those who, while interested in the subject, have had their attention called to it but recently, and are not familiar with events which occurred some years ago. During these first fluctuations of the market, the smelting works did not wish to buy ores, and for the same reason the large producers did not care to sell. When the price became steady again, most of the mines which could still be worked at a profit resumed operations. Those at which the cost of production was high, remained idle. Two results of the new order of things have, however, already become fixed, viz.: A reduction in the disproportionately high wages paid for labor in the Rocky Mountains and an increase in the production of gold.

The readjustment of the rate of wages, which became necessary through the less profits of the silver-lead, silver-copper and silver-gold mines, has not yet been completed, owing to the expected resistance of the miners and the disinclination of the employers to bring on a general struggle. Nevertheless, small reductions have been made nearly everywhere, and with this beginning it is likely that wages will soon settle to a reasonable basis. The effect of the fall in silver upon gold mining has been more decisive, the less profits to be realized in the production of silver immediately diverting attention to gold mining. Men thrown out of work by the closing down of the silver mines, engaged in rewashing the gravel of old placers in order to earn their living, while capitalists reopened old or low-grade gold mines, which had been neglected for many years in consequence of the greater possibilities of silver mining. Prospecting for gold was also stimulated and some important new discoveries were made. There was, of course, a falling off in the production of gold from the silver-gold mines, which had closed down, but this was more than offset by the new yield from the other directions mentioned, and the net result was an increase of $3,000,000 in the total gold output of the United States for the year, the total nearly reaching $36,000,000 in 1893, and $39,500,000 in 1894.*

INFLUENCES AFFECTING COST.

In endeavoring to ascertain the cost of the production of silver per ounce, it must be borne in mind that it is a very complex subject, and that probably with no other metal are so many influences at work which may raise or lower this cost.

Silver is found in connection with most of the ordinary commercial metals. It is found and worked in connection with gold, copper, lead, zinc, iron and manganese, and the cost of production is influenced to the greatest extent by the larger or smaller percentage of these metals. For example, a gold ore containing but a small and negligible quantity of silver is worked by the free-milling process, with or without concentrators. When the silver percentage increases, pans and settlers are required in addition to the simple quicksilvered plate that was in use for free-milling gold ores. Dry silver ores, *i. e.*, ores free, or nearly free, from lead, can be worked in a stamp mill with pans and settlers. Ores containing considerable quantities of lead, antimony or bismuth do not give an economical yield of their precious metal by the stamp mill, but require a smelting furnace, where the ore, with the addition of either silicious or basic flux, as the case may require, is melted with coke or charcoal by means of a blast, and the silver-lead combination taken in a fluid state from the lower portion of the furnace, and cast into bars, in which state it is known as base bullion. This base bullion is subsequently cupelled; that is the lead is oxydised off in the state of litharge, and the silver remains in a practically pure state.

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* Mineral Industry, Vol. II.

The litharge is retreated and recovered as lead, so that the price of these two metals in this case, exercises a mutual influence.

Silver ores, combined with copper, may be milled, the copper not exercising any especially injurious influence, but in this case the copper is lost. If the percentage of copper is high enough to be worth saving, this can be done by the copper-smelting process, in which both metals are saved.

The combination of silver with zinc is one which increases the difficulty, and with it the cost of the production of silver from such ores, as this combination is one which renders the ores harder to smelt, thereby requiring more fuel, gives the sluggish slag, which carries off silver mechanically mixed, and generally impedes the working of the furnace, thereby causing a smaller production.

Iron and manganese, or rather their oxides, are, on the contrary, of great advantage in the smelting of silver ores, and their presence, as a rule, facilitates the production, and therefore lowers the price. It is therefore plain that any general estimate of the cost of the production of silver must be made with the greatest care, and even then must be received with caution; that in cases where silver is a by-product, or a subordinate production, it will be impracticable to ascertain its cost per ounce, as it must vary continually in each individual case with the percentage.

The only practicable way is to ascertain the cost in mines producing silver alone, and average this with the supposed cost where other metals enter into the cost of production.

THE HOPE EQUATION.

Another element which has entered largely into the cost of production in the past, and still continues to affect the cost of production of gold, but not to such an extent as formerly the cost of silver, is what may be called the "hope equation." In this respect mines of the precious metals differ from all others. Iron mines, coal mines, copper mines, zinc mines, lead mines, are all worked on what may be called business principles. If the iron, coal, copper, lead or zinc is there in sufficient quantities, in the proper combinations, and with satisfactory transportation and labor rates, the mine will be worked. If the mineral or metal can be produced at a profit sufficient to keep capital interested, mining will continue until the deposit is exhausted, or its production from one of the above-mentioned causes becomes unprofitable. With the precious metals, gold and silver, this is not the case. Whether it is the poor coolie, washing the sands of the Shantung peninsula or grinding the quartz of the Jeh Sui mines in China; the Argonaut who panned the placers of the American Fork in California during the 50's; the companies who manipulated the mines of the Comstock lode with their alternate dividends and assessments; down to the Londoners who to-day are so wildly investing their capital in the South African mines; there is always the *hope equation.* The coolie might wash out but 2 cents in gold to-day, 5 cents being the necessary amount to keep him from starvation; there is always the chance, the hope, that to-morrow he will wash out 10 cents, or perhaps find an infinitesimal nugget of the value of a dollar, which would mean to him nearly a month spent in idle luxury.

The early California miners toiled hard, late and early, in water to their waists, under semi-torrid suns and frigid nights, and while prizes and fortune went to the few, the average man did not make wages.

In the Comstock mines some of the companies paid millions in dividends, others yielded only assessments, which were paid, perhaps not always willingly, but were paid in the hope that the money when spent might lead to the finding of some hitherto undiscovered bonanza, which would so advance the stock as to more than recoup the holder for the amount spent in assessments.

And to-day, in the "scramble for gold," when the British public is frantically investing its surplus capital in the Witwatersrand mines of South Africa, mines which seem to be good at present, and with our present knowledge, but which appear to be overcapitalized, and to which the reaction and panic sooner or later will probably come, this same *hope equation* is shown.

This idea has been elaborated by others, particularly with reference to gold. If we compare the total production of gold in California with the number of workmen, we get interesting results. In the beginning of the decade 1850–60, from 60,000 to 100,000 men were employed in the mines and washings of California.

One man produced annually no more than between $500 and $1,000, which meant, with daily wages ranging between $4 and $8 per day, a large deficit. In the middle of the decade from 1860–70, 43,000 men were employed (of whom 7,000 were employed in quartz mining) and altogether produced only $25,000,000 in gold. Quartz mining yielded at that time nearly $1,000 per year per man, the washings correspondingly less, with daily wages of from $2.50 to $3. Again there was an industrial loss. These facts correspond with the statements as to dividends, from which it appears that of several hundred quartz mines, hardly a dozen are profitable. In the washings, matters are no better. Even though the dividends in particular cases are large, they by no means cover the deficit of all the unprofitable undertakings. In fact, the production of gold in California, as in Australia, has always yielded a net loss. This may be explained as follows:

A few dozen mines produce the great mass of gold. They make large profits and determine the price. Their success attracts capital without end to similar undertakings; these are given up after awhile and the money is returned to other really productive branches of industry. But the temptation from the fortunate gold producers continues, and causes new capital constantly to rush to its destruction—the same phenomenon that is seen in games of chance. A few win a great deal, hundreds lose all they have. The business on a whole is a losing one, everybody knows it, yet every one stakes his venture in the hope of winning the great prize. For that reason the production of gold throughout the world has always been on the whole unprofitable, and gold has been an article which was sold below cost price. The decreasing gold production of California was supplemented in the 60's by that of other American States (Comstock, etc.). In recent times these sources also are being rapidly exhausted. Here, as in Australia, the production of gold is marked by a lack of permanence. This has always been the case, and is explained by the easy exhaustion of the alluvial deposits, and the small depth at which veins are profitable. In other countries the same phenomenon has shown itself in previous centuries; but, under the conditions of earlier times, when methods were more primitive, there was a longer period before exhaustion set in. In this respect gold differs essentially from the less exhaustible silver.*

In an inquiry into the cost per ounce of silver, both present and prospective, it is necessary to take into account the output of the various silver-producing countries of the world, and for our purpose, in view of the influencing events of 1893—*i. e.*, the action of the Hershell Committee and the United States Congress—the years 1893 and 1894 will be sufficient, and as gold and silver are so intimately related, the statistics of production of gold will be given at the same time.

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* Leitschrift für Berg, Hütten und Salinen, January, 1886.

THE WORLD'S PRODUCTION OF GOLD AND SILVER IN 1893 AND 1894.

Silver is taken at its average commercial value per ounce, which in 1893 was 78.2 cents, and in 1894, 63 cents:—

Gold, value of production in 1893	$158,437,551
Silver, commercial value in 1893..............	134,241,121
Gold, value of production in 1894	179,345,704
Silver, commercial value in 1894	105,429,034

The United States has lost the first place in gold-production, having been exceeded by Australasia by $290,670. Africa holds the third place, its production being $205,000 less than the United States. Russia holds the fourth place. These four countries furnish nearly five-sixths of the world's total production. In 1894 the United States produced the largest amount of silver, its commercial value being $31,403,053. It is closely followed by Mexico with $29,640,378. Bolivia stands third with $13,862,888, the greater part of which is the production of a single mining company. Australasia holds fourth place with $11,388,638, the larger part of which comes from Broken Hill and other points on the Barrier Range. These four countries furnish about 81 per cent. of the world's total production of silver.*

THE RELATIVE PRODUCTION OF GOLD AND SILVER.

The relative production of gold and silver, and the actual production of gold, are the most important questions in the mineral industry to-day, for on them depend the stability of the world's money, and in a measure the prosperity of a large part of the human race.

Approximately accurate statements of production of the metals have been compiled only since the discovery of America in 1492, and the aggregate output of the precious metals in the world since that date to the end of 1894 has been 12,470,477 kilogrammes of gold, and 242,019,823 kilogrammes of silver, or, in other words, the total production of the world since that date to the present time has been by weight in the proportion of 19.4 silver to 1 of gold, and in commercial value 16.18 silver to 1 of gold.

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* Mineral Industry, Vol. III.

In the 28 years from 1493 to 1520, the production of silver averaged by weight 8.1 times that of gold, while it required 10¾ of silver to equal 1 of gold in value. The production of gold grew very slowly during the 107 years from 1493 to 1600; while that of silver increased about 700 per cent., its output averaging in the 20 years ending with 1600 no less than 56.8 times that of gold, though its relative value declined only about 10 per cent., or to a ratio of 11.8 silver to 1 of gold. During the next century the output of silver actually declined, while that of gold increased. The relative weights averaged from 1680 to 1700, about 31.8 silver to 1 of gold, or nearly double the proportion in which the metals are at present produced (17.9 to 1); yet while it then required only 15 of silver to equal 1 of gold in value, it required in 1894 no less than 32.81 silver to equal 1 of gold.

RELATIVE VALUES.

During the 170 years from 1700 to 1870, the relative values of gold and silver varied only between the limits of 14¼ and 16¼ to 1 (which represents about the average coinage ratio), though the productive ratio fluctuated between the limits of 4 and 50 silver to 1 of gold. Thus from 1700 to 1720 the production was by weight about 28 silver to 1 gold; 100 years later, in 1800 to 1810, it averaged 50.3 silver to 1 of gold, and 50 years later, or from 1850 to 1860, it averaged only 4½ silver to 1 of gold.* The cost of production of 17,757,025 ounces of silver, as ascertained from the official reports of dividend-paying mining companies, this amount being 32½ per cent. of the entire United States product in 1890, was ascertained to have been, exclusive of interest on capital invested, 50.6 cents per ounce, and it was estimated that of the 65,000,000 ounces produced in 1892, one-half was produced probably at an average cost of 65 cents per ounce, and one-half at 90 cents per ounce, giving an average for the whole of 77.5 cents per ounce. It is certain that the mines which produced nearly 18,000,000 ounces in 1890, at a cost of 50.6 cents per ounce, could not now do so, notwithstanding the decline in wages and in many items of cost that have since taken place, because most of these mines are no longer in bonanza, and the grade of the ore has declined more rapidly than the cost of treating it. In any inquiry as to the average cost of producing the precious metals, the amount to be produced is an essential element in the problem. Probably more than 5,000,000 ounces are produced annually in the United States as a by-product in getting other metals, but if 65,000,000 ounces a year were now suddenly required, it certainly could not be produced at 77.5 cents per ounce.

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* Materials toward the elucidation of the economic conditicns effecting the precious metals. —Dr. ADOLF SOETBEER.

COMPARISON OF RATIO OF PRODUCTION WITH THE COMMERCIAL RATIO.

Further than this, the cost of producing such an amount in a year is increasing and will continue to increase until new bonanzas are found, and there is now little inducement to spend money in the costly search for these. If we find that the production ratio of silver to gold over a long series of years has not greatly differed from their commercial ratio, then we can conclude with a fair degree of accuracy that the profits on their production have not greatly differed; that is, that their relative cost has been about the same as their production ratio. For we assume as absolutely true that capital will go into the production of that which pays the best, taking due account of the risks in the business. While a gold bonanza, owing to the higher value of the metal, is probably more profitable than one of silver, yet the risks are greater. It may, indeed, be stated as a general proposition, with an approximation to the truth, that the profits in producing any of the metals is in a rough way inversely proportional to the unit value of the metal itself. No doubt, on the whole, the producing of silver is a more profitable investment for capital than that of gold, as the production of copper is more profitable than that of silver. It is, probably, also true that on the whole much more money is lost in the production of gold than in that of silver. Now, the total production of the world since 1492 amounted to 12,470,477 kilogrammes of gold and 242,019,823 kilogrammes of silver, or in the proportion of 19.4 silver to 1 gold. Taking the values of the metals at their current value ratios throughout that period, the average relative values of this gold and silver were as 16.18 to 1, that is assuming gold to be worth $20.67 per ounce troy, or $664.60 per kilogramme, the value of the silver would be $1.27 per ounce. The average relative cost of producing the metals in the last 402 years may be counted as between the average production and value ratios; that is to say, between 16.18 and 19.4 to 1, and a reasonable ratio for coinage at the present time would, considering the trend of the ratio value, be perhaps 18 to 1. The late Dr. Soetbeer suggested as a fixed ratio for universal bimetallism 20 to 1 ($1.03 per ounce for silver), and this is a proportion which would over a long series of years favor the production of gold.*

TESTIMONY AS TO COST FROM MINING COMPANIES.

In 1887 the Director of the Mint addressed letters to all the principal silver mines in the United States, and the results when tabulated showed that 155 mines in the United States produced, at a cost of 52.4 cents per ounce, 17,655,387 ounces of silver, which was 43 per cent. of the total production of that year.

For the years ending 1892 a computation has been made from official reports of silver and gold mining companies, which were all dividend-paying.

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*Mineral Industry, Vol. III.

At the Alice Gold and Silver Mining Co., Montana, during the period 1880–92, the cost per ounce of silver produced ranged from 85 to 97 cents.

At the Elkhorn Mining Co., Montana, for the years 1890 and 1891, the cost of silver was 45 and 41 cents per ounce, respectively. The chairman of this company made a speech at the stockholders' meeting in 1894, stating that the company was prepared to keep its mines in operation, and expected to make a profit as long as the price of silver did not fall below 20d. (43.8 cents) per ounce. This property yields gold, silver and lead.

At the Granite Mountain Mining Co., Montana, between the years 1881 and 1892, the cost of production per ounce of silver varied from 25 cents to 78 cents.

At the Daly Mining Co., Utah, from 1884 to 1891, the cost varies from 42 to 68 cents per ounce.

The Ontario Mining Co., Utah, varied in the fourteen years before 1891 from 44 to 71 cents per ounce.

The Small Hopes Mining Co., Colorado, in twelve years ending 1892, produced at rates between 19 cents and 50 cents per ounce.

At the Broken Hill Proprietary Co., Australia, in seven years anterior to 1892, the price of production of silver varied from 40 to 66 cents per ounce, lead being produced at the rate of 1.4 to 2.3 cents per pound.

The Alaska Treadwell Gold Mining Co. produced gold in 1891, 1892, 1893 and 1894 at the rates of $9.88, $10.71, $8.77 and $7.125 per ounce, respectively.*

The El Callas Gold Mining Co., of Venezuela, South America, between 1881 and 1892, produced gold at costs between $6.30 and $17.97 per ounce.

The Drumlummon Mine, Montana, between 1885 and 1892, produced silver at costs varying between 47 cents and $1.33 per ounce, and gold at costs varying between $7.56 and $21.24 per ounce.

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*This company has at present ore in sight, 2,200,000 tons.

In Butte, Montana, the cost of producing silver in 1891 averaged about 80 cents per ounce.

The Mollie Gibson Mining Co., Colorado, reported for the year ending December 31, 1894, that the expense of mining its silver was 21.3 cents per ounce, and the expense of freight, smelting and royalty was 14.3 cents per ounce, making a total of 35.6 cents per ounce.

The Mount Morgan Gold Mining Co., Queensland, produced £489,001 of gold, during the year ending May 31, 1894, at a cost of $8.32 per ounce.

The Alaska-Mexican Gold Mining Co. during the year ending June 30, 1894, obtained $101,114 gold at a cost per ounce of $15.14.

The Engineering and Mining Journal under date of November 24th states: " It is probable that an average price of 60 cents per ounce would not secure the normal production in this country of more than 30,000,000 ounces of silver a year. To secure a regular output of 40,000,000 ounces an average price of 65 cents would be necessary, and to increase the normal output above 40,000,000 ounces the average price would have to advance quite rapidly with the quantity."

LAST DIVIDEND PERIODS OF WELL-KNOWN SILVER MINES.

Taking the previously-mentioned silver mining companies that produced about one-third of the total production of the United States in 1890 at a cost of 50.6 cents per ounce, and following out their record to the present time, we find that the Alice Gold and Silver Mining Co. paid its last dividend in April, 1891.

The Granite Mountain paid its last dividend in July, 1892. The Daly in May, 1893. The Ontario in October, 1892. The Small Hopes in October, 1893.

The Elkhorn and Mollie Gibson appear to be the only silver mines in the series mentioned which have been enabled to keep up their dividends, showing that their cost of production per ounce is considerably below the market price.

Taking the general list of the dividend-paying silver and silver-lead mines of the United States, we find that their last dividend periods were as follows:—

Adams	Colorado	Silver Lead	Jan., 1892
Alice	Montana	Silver Lead	Nov., 1891
Aspen	Colorado	Silver Lead	July, 1894
Badger	Ontario	Silver	Mar., 1890
Belle Isle	Nevada	Silver	Dec., 1879
Belle Vue	Idaho	Silver Lead	Jan., 1890
Bunker Hill	Idaho	Silver Lead	Oct., 1888
Centennial Eureka	Utah	Silver Lead	Aug., 1895
Cryolite	Colorado	Silver Lead	Dec., 1884
Cœur d'Alene	Idaho	Silver Lead	June, 1893
Colorado Central	Colorado	Silver Lead	April, 1893
Commonwealth	Nevada	Silver	Nov., 1890
Confidence	Nevada	Silver Lead	April, 1889
Contention	Arizona	Silver	Aug., 1892
Cook's Peak	New Mexico	Silver Lead	Nov., 1892
Cortes	Nevada	Silver	Feb., 1893
Daly	Utah	Silver Lead	May, 1893
Elkhorn	Montana	Silver	May, 1895
Enterprise	Colorado	Silver	June, 1893
Evening Star	Colorado	Silver Lead	Dec., 1889
Grand Prize	Nevada	Silver	Mar., 1884
Granite Mountain	Montana	Silver	July, 1892
Helena and Frisco	Idaho	Silver Lead	Feb., 1892
Holmes	Nevada	Silver	April, 1892
Hope	Montana	Silver	Jan., 1895
Horn Silver	Utah	Silver	June, 1895
Illinois	New Mexico	Silver	April, 1889
Iron Mountain	Montana	Silver	Aug., 1895
Iron Silver	Colorado	Silver Lead	April, 1889
Leadville Cons	Colorado	Silver Lead	Feb., 1893
Little Chief	Colorado	Silver Lead	Dec., 1890
Mollie Gibson	Colorado	Silver	Jan., 1895
Morning Star	Colorado	Silver Lead	Dec., 1891
Mount Diablo	Nevada	Silver	Nov., 1893
New Guston	Colorado	Silver	April, 1892
North Belle Isle	Nevada	Silver	May, 1888
Ontario	Utah	Silver Lead	Oct., 1892

Richmond	Nevada	Silver Lead	Sept., 1893
Robinson Cons	Colorado	Silver Lead	Mar., 1886
Savage	Nevada	Silver	June, 1869
Silver King	Utah	Silver	Aug., 1895
Silver Mining Co., L. V.	New Mexico	Silver	Dec., 1891
Small Hopes	Colorado	Silver	Oct., 1893
Ward Cons.	Colorado	Silver	Dec., 1889
Yankee Girl	Colorado	Silver	July, 1891

This list shows that of forty-five silver and silver-lead mines, eight only have continued their dividends since the fall of silver to the neighborhood of 67 cents per ounce. It would therefore be reasonable to infer from this that these mines, if working, are able to produce silver at but a small amount less than its present selling price of 67 cents per ounce, and if they are closed down completely, that they are unable to produce it at that price.

THE PRESENT AVERAGE COST OF PRODUCTION IN THE UNITED STATES NOT FAR REMOVED FROM ITS PRESENT SELLING VALUE.

It has been previously shown that the price per ounce in 1887 for two-fifths of the production of the silver mines of the United States was 52.4 cents per ounce, and for one-third of the production in 1890 was 50.6 per ounce, and that the production of the entire amount in 1892 was probably at a cost of 77.5 cents per ounce. At the present writing only about 18 per cent. of the before-mentioned dividend-paying mines survive as dividend payers, many of them are worked in a desultory way by "leasers," and some are able to do little more than pay expenses. In the two years previous to 1895 there have been no remarkable labor or material-saving inventions in either silver mining or smelting, and as the price of labor in the West is but slightly reduced, and the changes in the price of material have not been great, it follows that the cost of production has been reduced but fractionally.

Taking all that has been previously said into consideration, the few silver mines that are left as dividend payers, the large number shut down or doing no more than paying their way, the price of silver per ounce as ascertained of 43 per cent. of the production in 1887, and of 33 per cent. of the production in 1890, and the estimate made of the average cost of the entire production in 1892, **it is probable that the present average cost of the production of silver in the United States is not far removed from its selling value, and is about 65 or 66 cents per ounce.**[*]

THE COST OF PRODUCTION OF SILVER IN THE UNITED STATES AS LOW AS THAT OF ANY OTHER COUNTRY.

The United States probably leads the world in its methods for mining, milling and smelting silver, and it is probable that notwithstanding the higher price of labor, its average costs of production of silver are as low as those of any other country.

It has been said that the commercial productive value of silver is the point at which capital abandons its production and seeks that of gold, and it is likely that this would afford an approximate relative average cost of the production of the two metals, as previous to the summer of 1893, mining capital apparently had no fear of investments in silver mines. Since that time with the price of silver varying between 60 and 70 cents per ounce, it has been almost impossible to induce the investment of capital in silver mining.

FUTURE COST OF SILVER PER OUNCE.

The question of the future cost per ounce of silver is one that is influenced by a number of opposing causes, some having a tendency to raise the price, and others to lower it. Paradoxical as it may seem, one of the reasons which would increase the average cost would be an increase in the selling price. We have attempted to show in the previous pages that the present average cost of production of silver is about the same as its selling price in the world's markets; that notwithstanding there is a small percentage of mines that produce for a less cost than this, over three-fourths of the number have ceased being dividend payers, and are clearing but little more than expenses, while waiting for an advance in the price of silver, or doing expensive underground prospecting in the hope of discovering new bonanzas.

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[*] The price mentioned was the current quotation at the time this pamphlet was written.—EDITOR.

The average cost of production in silver mines may therefore be taken at about the selling price of silver. As soon as the price of silver is sufficiently high to attract mining capital to it instead of turning to gold (which as we have shown is between 80 and 85 cents per ounce) capital might turn again to silver, which would lead to the working of lower-grade mines, the high-grade ones being already in the hands of capital or worked out, and while perhaps not actually causing an advance in the price of labor in the West, would have a tendency to stop the pressure to reduction which is felt there at present.

More silver mines would be opened as the price increased, a few as in the past would be successful, but the majority would fail or perhaps simply make expenses, the *hope equation* previously mentioned having a great effect in keeping them in operation. Thus it is shown that assuming a slight increase in the selling price of silver, the average cost of production would probably not be far behind it.

VALUE OF THE PRODUCTION OF SILVER IN THE UNITED STATES.

The *Engineering and Mining Journal*, under date of September 14, 1895, says, in speaking of the production of silver, that "the new supply of metal is evidently smaller than it was last year, as production has been reduced not only in our own country, but from other important sources. The Great Broken Hill Mines, in Australia, will apparently send out a limited amount for some time to come, and it is doubtful whether their production will ever again reach the point at which it was maintained for several years prior to 1894.

There is every indication that the price will not fall below the present figures, and the tendency will be rather to higher ones." In the United States the value of the production of silver in 1893 held fourth place among the mineral productions. The output was 60,500,000 ounces, with a commercial value of $47,311,000; it was exceeded in value by the output of anthracite coal, bituminous coal and pig iron.

In 1894 the value of the production of silver held the eighth place among the mineral productions. The output was 49,846,875 ounces, with a commercial value of $31,403,531, being exceeded by anthracite, bituminous coal, crude petroleum, copper, gold, pig iron and building stone.

The production of silver in the United States in 1893 was not so much smaller than the previous year, as might have been expected from the general closing down of the mines, being a decrease of only 3,500,000 ounces, but this was due to the fact that all the smelting works had large stocks of ore which they smelted after the output of many of the mines had ceased. It was not therefore till August or September that there began to be a perceptible reduction in the output of silver, but in the autumn many of the works, including all those of Leadville, blew out their furnaces for lack of ore.

As the production of silver in the United States is influenced by its selling value, and the selling value is determined by the output of other countries as well as the United States, a cursory study of what is being done in the other precious metal-producing countries of the world becomes pertinent to the object of this paper; and as the production of gold and silver is always considered together in statistics, and they exercise an influence on each other, they will be considered together.

THE WITWATERSRAND GOLD MINES IN SOUTH AFRICA.

In South Africa there has been a most remarkable development of a gold district, known as the Witwatersrand mines.

These mines are unique in the world's history of gold mining. Ordinarily, quartz mining for gold is on what is known as either a fissure or a contact vein, *i. e.*, either a crevice cutting the formations, subsequently filled with gold-bearing quartz, or a lenticular mass of mineral lying at the contact of two different formations. In either of these cases, the rich and workable portions of the vein are generally confined by irregular, more or less vertical planes to narrow limits called chimneys, besides being bounded by the walls of the vein.

In the conglomerate or "banket" beds of the Transvaal, which are so called because of their resemblance to a Boer cake of that name, the occurrence of the gold-bearing rocks is entirely different. These gold-bearing rocks consist of regular beds interstratified with sand stones, they outcrop for over 50 miles, and the workings along the outcrop extend for a distance of over 11 miles. They also form a basin, the opposite outcrops occurring at over 30 miles distance. There are numerous workable ledges, the principal one of which has a thickness between 4 and 20 feet. The average yield from the district was in 1893 14 pennyweights per ton, obtained at a cost of $6.43, or in other words the gold is obtained at the cost of $7.72 per ounce. The gold production of Africa, which includes other subordinate districts besides the Witwatersrand, for the year 1891 was 729,238 ounces; for 1892, 1,210,868 ounces; for 1893, 1,478,473 ounces; for 1894, 2,024,159 ounces, and for 1895, as June, July and August have been producing at the rate of 200,000 ounces per month, it is probable that the total amount for the year will reach nearly 2,350,000 ounces.

In 1892 there were 1887 stamps crushing the Witwatersrand ore, and the number has greatly increased since then. The difference between the average gold-quartz mine and the gold mine on the Witwatersrand "banket" ledges is that in one case there is uncertainty of thickness of the ledge, uncertainty of extent of the pay chimney, variation in the richness of the rock crushed, sometimes high, sometimes low; while in the other, the ledges maintain their working thickness, the ore does not appear in chimneys, the rock maintains its average richness, sometimes going as high as $60 to a ton, and seldom going under the cost of extraction and beneficiation.

Ordinary gold mining is as uncertain, venturesome and risky an investment for capital as can be found, while mining in the Witwatersrand district is quite as safe an investment for capital as coal mining.

ESTIMATED AMOUNT OF AVAILABLE GOLD EXISTING IN MINES.

It is estimated by Mining Councilor Smeisser, a mining expert, that the amount of gold that can be obtained above the depth of 3,936 feet, which is a depth that has actually been reached in ore mining at Przibram, Bohemia, is $1,696,140,000.

Mr. Hamilton Smith, mining expert for the Rothschilds, has estimated that the amount of gold existing in the mines above 3,000 feet in depth is $1,044,900,000.

It is estimated that at the present rate of increase it will require forty years for the exhaustion of these deposits.

British Columbia produced $379,534 gold in 1893.

The production of gold in the Mysore district of India was 207,135 ounces, an increase over the previous year, 1892, of 44,000 ounces. No silver was reported as produced in India. The exports of gold from Shanghai, China, were $450,000, a great increase over 1892. China is also a silver producer from the mines of Yen Tung Shan and Ku Shan Tzu in Inner Mongolia. These mines were at one time worked by American methods, but the grade of the ore was too low, and the deposits too irregular for profit, and they are now being worked in a desultory way by Chinese methods. The production is small, perhaps 50,000 ounces per year.

The production of gold in Russia for 1892 was $24,655,955. No detailed amounts for 1893 have been published, but indications are for an increase of the production of 1892.

AMOUNT OF PRODUCTION OF GOLD AND SILVER IN FOREIGN COUNTRIES.

The silver production of Russia in 1892 was 13,722 kilogrammes, a falling off from 1887 when it was 15,362 kilogrammes. We may look for an increase in the silver production of Russia because of the Trans-Siberian Railroad. The silver mines of the Tomsk and Semi-Palatinsk districts in Western Siberia, and the Nertchinsk district in Eastern Siberia, are at present worked only in a limited way, on account of the high cost of fuel and supplies, but the ore deposits known are sufficient to furnish a very much greater output when the railroad is so far completed as to transport these necessities to the reduction works.

Mexico, in 1893, produced $1,321,114 in gold and $58,388,505 in silver, an increase in both the amounts of silver and gold over the preceding year.

The only parts of Spain in which silver ores are exploited at present are in the province of Guadalajara. The argentiferous wealth of Spain, once so famous among the Carthagenians and Romans, has materially diminished in modern times, nor is gold found in any appreciable quantity in the Spanish peninsula. The production of silver in 1892 was 85,500 kilogrammes, in 1893 it was 90,000 kilogrammes. A kilogramme of silver is $39.109 coinage value.

In twenty years 43,600 tons of ore have been extracted from North Wales mines in Great Britain. These ores yielded 23,716 ounces of gold, or about $11 to the ton. The extraction of ore in 1893 was 4,300 tons.

Silver in Austria can be mined in sufficient quantity to supply the home demand, but is now quoted so low that the mines producing it are seriously threatened with idleness. The production of Austria-Hungary is 54,000 kilogrammes, valued (1893) at $23.20 per kilogramme, or 74 cents per ounce.

For example, if the Imperial smelter at Przibram, with a production of 35,000 kilogrammes of silver, formerly made a profit of 80,000 florins, to-day, at the difference of value, a depreciation of 32 florins, these same works lose a yearly income of 35,000 kilogrammes × 32 florins = 1,120,000 florins. During 1893 the Minister of the Treasury has permitted the mints to buy silver bullion for as much as 80 florins ($32) per kilogramme. Next year it is probable that a much lower rate will rule, and finally silver will not be purchased at all. Then the Staatswerke Przibram, which now employ over 500 workmen, may be closed down permanently, and the same thing might be predicted for all the public and private works in Hungary which formerly received a good income from the sale of silver ore or bullion. Bosnia produced, in 1892, 41 tons of silver-lead ore, valued at $1,680.

Canada produced, in 1893, $321,423 silver, coinage value, an increase of $52,000 over 1892, but a falling off of $100,000 since 1890.

The silver exports of Chili in 1891 were $5,171,000; in 1892 they were 5,318,925, in the shape of bars and old plate, but omitting silver-lead ores, silver ores and silver sulphide ores, so that there appears to have been a substantial increase. The production of silver in Germany, in 1892, had a value of $14,307,172; in 1891, $14,749,420, and in 1890, $14,037,716.

The smelting works at Laurium, Greece, treated only old slags and dump heaps in 1893. The slags are nearly worked out, and of the dump heaps only the poorer portions remain, those containing 3 to 4 per cent. of lead, and 2½ to 3 ounces of silver. Silver concentrating works, capable of treating 1,000 tons of raw material per day, were completed during the year. There were 6,700 tons of bullion produced in 1893, a little more than half being obtained from new workings, from which only the purest galena was extracted. The average silver contents of the lead was 667 ounces per ton.

The silver mines of Milo are estimated to contain no less than 10,000,000 tons of ore, which is not rich, containing about 5½ ounces of silver to the ton.

The engineers being of the opinion that ore averaging 8⅓ ounces per ton, which exists in parts of mines, could be worked profitably in large quantities, the Government in February, 1893, offered to grant a lease to the highest bidder to mine 150,000 tons within fifteen years.

It was easy to foretell that under these conditions, and with the low price of silver, no one would undertake to mine 8-ounce ore.

In Italy, the silver and silver lead mines of Sardinia increased in value of output from $600,000 in 1860 to $2,000,000 in 1877, Since that year the value has fluctuated between $1,200,000 and $1,500,000. Although the quantity mined has increased, the value of the ore has diminished.

Norway produced $161,876 of fine silver in 1892, falling from a maximum production of $247,000 in 1885.

Sweden produced 5,211 kilogrammes of silver in 1892, and 5,741 kilogrammes in 1891.*

The celebrated silver mines of Huanchaca are situated in the department of Potosi in Bolivia, at a height of about 13,500 feet above sea level. The silver lodes occur in soft decomposed trachyte. The actual silver-bearing mineral is fahl erz, containing about 10 per cent. of the metal. The percentage of silver increases with the depth of the mine. The accompanying minerals are galena, blende, iron pyrites, copper pyrites, heavy spar and quartz.

The main lode runs about east and west, and is from 3 to 10 feet in width.

The output of silver in 1891 was 792,279 marcos, 900,870 marcos in 1892, 1,221,769 marcos in 1893 and 1,114,355 marcos (9,249,146 ounces) in 1894. The ore in sight in this mine is estimated year by year, and the estimate made December 31, 1894, shows 4,018,455 marcos, or nearly four years' supply at the present output. This company is producing silver at a cost of 42.2 cents per ounce, and paid £256,000 in dividends in 1894.

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*The preceding statistics were taken from the Mineral Industry.

The Broken Hill Mines, of New South Wales, Australia, are remarkable for their enormous output of silver and lead during the past few years. The deposit is generally spoken of as a vein or lode, but further developments may prove it to be a bed. The dip varies, but is always steep. Near the surface the vein consisted of dark brown hematite ores of manganese and carbonate of lead. Below the weathered zone come sulphides, especially galena and zinc blende, together with iron pyrites, copper pyrites and mispickel.

In the seven years ending May 31, 1892, the principal mine produced 36,512,445 ounces of silver and 151,945 tons of lead, worth altogether £8,252,138, of which £3,896,000 has been paid in dividends. During the last few years the oxidized ores have been almost exhausted, and the company has been forced to study methods of utilizing its sulphuretted ores, which up to the present time it has not been able to treat at any considerable profit. The proposed smelting works are to be established at Lake Illawarra, near Sydney, N. S. W., and within a few miles of the coal mines. Coal is to cost 6s. a ton unscreened, and 3s. 6d. for small coal. It requires three tons of coal to treat one ton of ore. The cost of mining the sulphide ores is 10s., and the mining company will be satisfied with a profit of £1 per ton. Taking July 8, 1895, prices, a profit to the smelting company on the ton of ore, containing 22-ounce silver, 25 per cent. lead and 25 per cent. zinc, is estimated at £1 11s. 6d. on the silver and lead, and £1 10s. 8d. on the zinc when reduced to spelter, or after allowing 10s. a ton for contingent expenses, a net profit of £1 12s. 6d. per ton of ore. This will correspond, if they are able to work to their estimate, to a production of silver at a cost of 57 cents per ounce.

The Mount Morgan Gold Mine in Queensland, Australia, appears to be the product of a geyser, and the deposit is shaped not unlike a mushroom, the upper part of the mushroom being the part worked, and the stem the chimney through which the sinter ascended in the shape of solution. The quantity of ore treated by chlorination in the twelve months ending November 30, 1889, was 75,415 tons, from which 323,542 ounces of gold were obtained, equal to 4 ounces 6 dwt. per ton. The gold was sold for £1,331,484 and £1,100,000 werepaid in dividends, so that it was produced at the rate of about $3.58 per ounce.

The *Engineering and Mining Journal* of March 13, 1895, sums up the silver situationin the following words: "Outside of our own country, while the conditions affecting the silver mines have shown a less marked change, there is certainly no tendency to increase of production. Few of the great silver mines of South America or Mexico are at present in bonanza, and in most of them the cost of production is gradually increasing to a point where profit is not to be expected without a material rise in prices. Moreover, there is less inducement now to prospectors, and fewer new discoveries are to be looked for. In Australia the chief producers at Broken Hill were pushed to their utmost capacity for reasons which a broker in mining stocks will appreciate, but the managers admit that the high-grade ores are being rapidly exhausted, and that the mines must depend hereafter on the low-grade sulphides, which means a decrease in the output and a very large increase in the cost. Under these circumstances, while the present stocks of the white metal are abundant, large additions to them are not probable, and no great accumulated stocks anywhere are likely to be thrown on the market."

THE OUTPUT OF GOLD INCREASING.

The "Mineral Industry," Vol. III, in its retrospect for the year 1894, stated that the year saw a still further expansion of the output of gold, and a slight reduction in the world's production of silver, though in the United States the output of the white metal declined about 18 per cent.

The working out of old bonanzas here and in other countries progresses, and few new silver mines are being opened, so that the output of the metal will certainly decline during some years to come, whatever the commercial value may be, and the decline will be very large if the value of the metal remains low. The output of gold on the other hand is increasing, new bonanzas are being opened, and until checked by the diversion of capital now so lavishly and frequently so unwisely invested in it, this increase will continue. The low price of silver, and the widespread discontinuance of its use both in money and in the arts, and the constant fear that the few silver-basis countries still remaining may also stop its use, render the immediate future of the metal very uncertain and gloomy, and discourage investment in its production.

The progress in metallurgy has undoubtedly lessened very greatly, and in a measure equally the cost of extracting gold and silver from their ores, but as the cost declines, lower and lower-grade ores are treated, so that the cost of producing a large part of the output each year will always approach and very often exceed the commercial value of the metal produced. It is the rare and fortunate owner of the bonanza who profits by the reduction in the cost of mining the precious metals. The average producer, in constant expectation of finding richer ore, works down until there is little or no profit, whatever the commercial value of the metal may be; in fact, the higher this is, and consequently the more valuable would be a bonanza, the more money will be lost in the search for ore and in working unprofitable ores.

SUMMING UP OF THE ARGUMENT AS TO THE FUTURE COST OF SILVER.

From the preceding pages it has been shown that in the precious metal-producing countries that are on a gold basis, the attention of mining capital is being given almost exclusively to gold, and, therefore, in the United States, Australia and Russia we see a diminution of the amount of silver produced, and the bonanzas already discovered are being exhausted without sufficient prospecting going on for the discovery of new ones.

In the countries that are on a silver basis, on the contrary, the production of silver is increasing. Mexico, Bolivia and Chili all show a considerable increase over the preceding year.

It may be that in these countries, none of which are gold producers to any great extent, the attention of mining capital is retained by one metal, and does not have the choice between the two that it has in the United States and Australia.

The statistics of the past two years show a gradual though slight diminution in the world's production of silver, and the probabilities are that the price will hold its own, affected to some extent by speculation whenever silver is made the subject of special legislation; that there will be a very gradual stiffening of the price, perhaps to the extent of 1 cent an ounce per year. The price of production, as has been already shown, will, by the working of lower-grade ones, the development of additional prospecting and other reasons, keep close to the selling price. **This advance of about 1 cent per ounce per year will probably continue, and should it, as is likely, last a score of years, it will bring the price to a point, about 85 cents per ounce,* where it would be equally profitable for mining capital to be invested with either of the precious metals, and that point once established, with no extraneous legislative influences, the price might be expected to remain at the above-mentioned figure for an indefinite period.**

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* At the ratio of 16 to 1, the price of silver should be over $1.29 per ounce to make the intrinsic value of the present silver dollar equal its face value.—Ed.

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